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DEPARTMENT OF DEFENSE
ARMED FORCES SPECIAL WEAPONS PROJECT
WASHINGTON 25, D. C.

ADDRESS REPLY TO:
THE CHIEF, ARMED FORCES
SPECIAL WEAPONS PROJECT

18335

7 MAR 1956

SWPEF 972.5

SUBJECT: Priority of Effects Program for Operation REDWING (U)

DNA1.940930.002

TO: Commander
Joint Task Force SEVEN
Washington 25, D. C.

1. During past atomic test operations it has been advantageous for the Task Force Commander to have available for operational purposes information on the background and the relative importance of specific detonations in regard to planned Department of Defense effects programs. It is believed that the following information coupled with the Atomic Energy Commission's planned objectives will provide assistance in rendering decisions concerning operational problems which may arise during Operation REDWING. Shown below is the Armed Forces Special Weapons Project evaluation of the relative priority of various detonations at Operation REDWING for DOD effects tests and the priority of the programs within these detonations:

Shot Priority		Program Priority
a.	Cherokee	1-2-3-5-8 equal priority, 4
b.	Zuni	2-5-1-8-4
c.	Flathead	2-5-4-8-1
d.	Tewa	2
e.	Lacrosse	1-5-8-2-4
f.	Navajo	2-5-1
g.	Apache	5-2-1
h.	Erie	5 (particularly Project 5.9)
i.	Inca, Yuma, Mohawk	All programs have equal priority
j.	Huron, Blackfoot, Osage, Kickapoo, Seminole	No relative program priority

Declassified WITH DELETIONS by DNA, Chief, ISTS
Date: 28 Aug 74

2. The Cherokee event, which was requested by the DOD, is considered as being the most important of the series as regards DOD effects programs. The readiness and probability of success of the effects programs should be the controlling factor in the decision as to the timing and conditions of detonation of this device. Program 3, an important and costly experiment, is entirely dependent upon this detonation. Portions of other

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SWPEF 972.5
SUBJECT: Priority of Effects Program for Operation REDWING (U)

programs, particularly 1, 2 and 8 depend on this detonation as their only source of information. The success of important parts of Programs 1 and 8 (Projects 1.3, 1.4 and 8.1) is highly dependent on atmospheric conditions. Careful consideration of cloud coverage is necessary in order to obtain photographic coverage and thermal measurements from ground stations.

3. In regard to the entire series, Programs 2 and 5 are generally the most important and are particularly difficult because they involve the movement of equipment into position prior to detonation time. For further information, attached as Inclosure 1 is a detailed discussion of each program giving the relative importance of the major projects within the program. In some cases no attempt has been made to establish an order of priority of the projects because they are interdependent and cannot be considered separately.

4. The fall-out program (2) is of particular importance in the test series as can be seen from the above priority listing. The magnitude and complexity of this program indicates special effort during and after the events to insure obtaining as much usable data as possible. The presently planned fall-out control room manned by a highly organized group on board the command ship is considered to be an effective method of coordinating the various elements of this program. In addition to complete coordination, the success of the fall-out program dependsto a great extent on the detailed accuracy of the measurements which can be made after each event. This accuracy will depend mainly on the background radiation level existing at the time the fall-out from the detonation is being measured. This will be a particularly important factor in the Cherokee detonation and also in the "clean" events because fall-out is expected to be of low intensity. Restrictions as to total yields and individual yields permitted to be fired prior to, and subsequent to, Cherokee and other large yield devices were agreed upon during the early planning of Operation REDWING. With the firming of expected yields and approximate ready dates for the detonations, it is now possible to relax considerably those restrictions. The following revised restrictions, which have been coordinated with the Atomic Energy Commission and AFOAT-1, are pertinent:

a. Prior to Cherokee

There are no restrictions as to the number of detonations provided that Cherokee is the first detonation of the series having a yield in excess of 200 KT, and provided that the background level in the vicinity of the Bikini Atoll will not exceed 25 mr/hr at the anticipated time of Cherokee + 1 hour.

SWPEF 972.5
SUBJECT: Priority of Effects Program for Operation REDWING (U).

b. All detonations subsequent to Cherokee

No device should be detonated which can produce a predicted background level in the fall-out pattern which is greater than 0.01 of the most intense fall-out contour (not induced activity) being measured during the fall-out survey period. This places both Bikini and Eniwetok predicted detonation intensities in the vicinity of the Bikini Atoll on a sliding scale. It is expected that about seven days are needed to document a detonation locally, worldwide, and to prepare for the next event.

5. A copy of this letter has been forwarded to Field Command, AFSWP, and to the Division of Military Application, AEC. In addition extra copies are inclosed for Dr. Gerald Johnson and Dr. Gaelen Felt, Task Group 7.1, who have expressed an interest in this material.

A. R. Luedecke
A. R. LUEDECKE
Major General, USAF
Chief, AFSWP

1 Incl:
Discussion of Operation
REDWING programs (4 copies)

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This document consists of 36 pages
No. 1 of 15 copies - Series A

8 February 1956

HEADQUARTERS
ARMED FORCES SPECIAL WEAPONS PROJECT

OPERATION REDWING

CONCEPT OF AIR BLAST AND SHOCK PROGRAMS

1. Philosophy

The blast and shock projects planned for Operation REDWING are essentially designed to obtain data for which there is an urgent military requirement and which cannot be obtained at the Nevada Test Site. The greatest effort will be devoted to establishing the basic blast phenomenology of a high yield air burst by measuring various blast wave parameters in free air and along the surface, as well as determining the loading and response of various targets from a long duration blast wave. The next most important task will be to establish the basic blast phenomenology of a medium yield land surface burst by similar means although in a less extensive manner. It must be recognized that neither of these tests are being conducted under conditions representative of many target areas which would generally require a semi-infinite land mass. However, present safety requirements are such as to preclude such tests within the continental United States. Therefore, every effort must be made to obtain representative effects data that can be applied to areas of more significant military interest. It must be realized that environmental conditions in the Pacific are such as to give rise to many difficult problems in making blast and shock measurements, such as the availability of suitable land areas, yield variation of individual shots, weather delay and wave action, as well as construction costs which make it necessary to use self-recording gages or existing shelters wherever possible, with a minimum of new construction. In general this philosophy covers the remaining objectives of the air blast and shock programs for Operation REDWING which are listed in order of priority in the next section. Justification of these major objectives are to be found in AFSWP-807, Analysis of Atomic Weapons Effects Programs. These major objectives are related to specific shots in paragraph 3. Justification and experiment design of the individual projects are contained in the AFSWP Project Summary and are described in more detail in the individual project proposals. A discussion of the principle objectives of each project is found in Paragraph 4, including participation in several events on a priority basis. While certain projects may desire to participate in other events, such participation must depend on the availability of personnel and equipment, as well as necessary operational support over and above that required to insure maximum success in achieving the major objective of the project. In general such participation must be approved on a non-interference basis and at no additional cost, depending on the availability of suitable land areas and recording shelters if required.

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2. Over-all Objectives

The over-all objectives of the blast and shock measurements to be made at Operation REDWING are as follows, listed in order of priority:

a. Establish the basic blast phenomenology of a high yield true air burst including shock wave propagation along the surface and in free air through a non-homogeneous atmosphere.

b. Establish the general blast phenomenology of a medium yield land surface burst, including shock wave propagation along the surface and in free air, as well as damage to drag sensitive targets.

c. Obtain data on structural loading and response resulting from a long duration blast wave.

d. Continuation of drag force gauge development program and application to structural shapes over a wide yield range.

e. Obtain data on blast wave parameters over a vegetated area for a precursor-forming tower shot.

f. Measure apparent craters resulting from land surface bursts over a wide yield range.

g. Determine basic blast phenomena from detonation of a fractional KT device.

h. Investigate water wave generation and propagation from high yield bursts.

3. Experimental Plan

The experimental plan to achieve these objectives is visualized as follows:

a. High Yield Air Burst - Shot Cherokee (Ready Date - 1 May)

A TX-15-X1 weapon with a yield of 4-5 MT will be air dropped to detonate at a height of approximately 5000 feet over Charlie Island (Nanu) in the Bikini Atoll. This height is about 300 feet scaled to 1 KT and represents a height somewhat less than 1-1/2 maximum fireball radius by cube root scaling. Project 1.3 (NOL) will employ both conventional low level 5" rockets and special high level Deacon rockets with EG&G high speed photography to obtain free air pressure distance data radially around the burst point with emphasis on the propagation through a non-homogeneous atmosphere up to 20,000 feet and out to the 6 to 8 psi region. Project 1.4 (AFCRC) will extend this data into the low pressure region and provide some overlap by positioning canisters at 15,000 to

40,000 feet in altitude to cover the 1 to 20 psi range. Direct shock photography will also be employed to study the effect of the reflecting surface on shock propagation including the early path of the triple point. Measurements of static and dynamic pressure will be made along the surface on land and reef stations by Project 1.1 (BRL) using self-recording gauges. Measurements will be taken at five-foot elevation at various distances to cover a pressure range of 5 to 200 psi. Project 1.5 (BRL) will also make electronic measurements of free field blast parameters at the Project 3.1 (WADC) structures location to provide partial electronic backup for the self-recording instrument program. Project 3.1 (WADC) will position six structures of the drag and semi-drag type used in Operation TEAPOT in Nevada at locations such as to receive comparable loading for a long duration blast wave. Project 1.5 (BRL) will also instrument these structures to determine loading and response with electronic gauges. Project 1.5 (BRL) will also measure drag force on structural shapes and spherical models at these same locations by electronic means. Project 1.9 (SIO) will measure water waves in the Bikini Lagoon and also at long ranges using instruments mounted in shore installations.

b. Medium Yield Land Surface Burst - Lacrosse I (Ready Date 1 May)

A LASL device with a yield range of 25-50 KT will be detonated on the surface of Yvonne Island (Runit) in the Eniwetok Atoll. Project 1.2 (SC) will make free field measurements of static and dynamic pressure along the surface with electronic instrumentation. Project 1.3 (NOL) will obtain peak pressure vs distance data vertically above the burst using conventional rockets as well as along the surface for correlation with measurements made by Project 1.2 (SC). Project 1.1 (BRL) will provide backup to Project 1.2 (SC) by making limited free field measurements of static and dynamic pressure along the surface using self-recording gauges at various ranges. Project 1.6 (NOL) will measure drag force on simple shapes such as spheres and other objects at various ranges using electronic instrumentation. Project 1.5 (BRL) will position jeeps in the 5 to 15 psi region for this shot in order to determine damage to drag sensitive targets for a medium yield burst where a precursor is not expected to occur. Project 1.8 (ERDL) will measure the apparent crater using photomapping techniques and lead line soundings.

c. Small Yield Tower Shot - Inca (Ready Date - 8 June)

An UCRL device with a yield estimated from 4-10 KT will be detonated on a 300-foot tower on Pearl (Rujori) Island in Eniwetok Atoll. Project 1.10 (SC) will measure free field blast parameters over a vegetated and cleared area from a medium yield shot where a precursor is expected to occur. Measurements of static and dynamic pressure will be made at various ranges along the surface using electronic instrumentation. Project 1.1 (BRL) will provide backup by making static and dynamic pressure measurements at various ranges along the surface with self-recording instruments. Project 1.3 (NOL) will

study shock wave propagation along the surface using direct shock photography.

d. Large Yield Surface Shot - Zuni (Ready Date - 15 May)

An UCRL device with a yield estimated at 1-3 MT will be detonated on the surface of Tare Island (Eninman) in the Bikini Atoll. Project 1.3 (NOL) will obtain pressure vs distance data along the surface and vertically above the burst using conventional low level 5" rockets and special high level Deacon rockets. Project 1.8 (ERDL) will measure the apparent crater by photo-mapping techniques and lead line soundings. Project 1.9 (SIO) will measure water waves in the Bikini Lagoon and at distant stations. Project 1.1 (BRL) will make measurements of static and dynamic pressure along the surface for correlation with measurements made by Project 1.3 (NOL) using self-recording instrumentation. Project 1.5 (BRL) will also position jeeps on this event to obtain data on long duration blast loading provided jeeps are available and suitable land area exists. Project 1.5 (BRL) will also re-instrument the CASTLE 3.1 structure on Uncle Island (ENIIRIKKI) with electronic instrumentation to obtain loading data from a long duration blast wave.

e. Fractional KT Device - Yuma (Ready Date - 1 June)

An UCRL device with a yield estimated between 0.1 and 0.3 KT will be detonated on a 200-foot tower on Sally Island (Aomon) in Eniwetok Atoll. Project 1.1 (BRL) will make limited measurements of static and dynamic pressures along the surface with self-recording gauges. Project 1.5 (BRL) will position jeeps on this event to obtain response data from a very low yield detonation.

f. Large Yield Barge Shots - Navaho (LASL-6MT-18 June), Apache (UCRL-2 to 3 MT-1 July), Tewa (UCRL-7MT-7 July), Flathead (LASL-300 to 500 KT-2 June), and Huron (LASL-100 KT-12 June)

These shots will be fired on a barge near Dog Island (Yurochi) in the Bikini Atoll. Project 1.9 (SIO) will measure water waves in the Bikini Lagoon and at distant stations for Navaho, Tewa, and Apache. Project 1.9 (SIO) will make limited measurements on Flathead and Huron in Bikini Lagoon only if project funds are available and little or no movement of instruments or stations is required.

g. Small Yield Land Surface Burst - Seminole (Ready Date - 28 May)

A LASL device with a yield estimated at 10 KT will be detonated at ground level on Helen Island (Bogairikk) in the Eniwetok Atoll. Project 1.8 (ERDL) will measure the apparent crater by photo-mapping techniques and lead

line soundings. (Participation on this event by Project 1.1 (BRL) and 1.3 (NOL) is considered necessary if adequate measurements are not obtained on Lacrosse I.)

4. Project Objectives

The main objectives of specific projects are listed below, as well as proposed shot participation in order of priority for each project. Secondary objectives are described in the AFSWP Project Summary Book, as well as in the individual project proposal. The minimum results expected are the successful participation of each project in the priority events:

Project 1.1 - Basic Blast Measurements (BRL)

To obtain basic air blast pressure-time and dynamic pressure-time data on Shots Cherokee, ~~Yuma~~, and ~~Zuni~~, using self-recording gauges at various ranges along the surface.

To provide backup measurements with self-recording gauges on Lacrosse I and Inca to obtain air blast pressure-time and dynamic pressure-time data at various ranges along the surface. (Participation in Seminole with self-recording gauges is considered necessary if adequate data are not obtained in Lacrosse I.)

Project 1.2 - Electronic Measurements of Static and Dynamic Pressures (SC)

To obtain free field measurements of static and dynamic pressure vs time on Shot Lacrosse I, using electronic instrumentation at various ranges along the surface.

Project 1.3 - Shock Photography (NOL)

To measure free air peak pressure vs distance for Shots Cherokee, Lacrosse I and Zuni using rocket trail photography. High altitude Deacon rockets will be used on Cherokee and Zuni in addition to conventional 5" smoke rockets.

To study shock wave propagation along the surface on Shots Cherokee, Lacrosse I, Zuni, and Inca using direct shock photography. (Participation in Seminole with direct shock photography is considered necessary if adequate data are not obtained on Lacrosse I.)

Project 1.4 - Free Air Pressure Measurements at Altitude (AFCRC)

To obtain free air pressure vs time measurements at various ranges for Shot Cherokee using parachute borne canisters at high altitude.

Project 1.5 - Drag Characteristics of Various Shapes (BRL)

To investigate the drag characteristics of actual and idealized shapes on Shot Cherokee, using structural I beams, angle sections, and spherical drag gauges.

To investigate the response of drag sensitive targets on Shot Lacrosse I, Yuma, and Zuni by evaluating damage to military vehicles.

To obtain loading data on the CASTLE 3.1 structure on Uncle Island (Eniirikki) for the Zuni event using electronic instrumentation to include free field blast measurements at that location.

This project will also instrument the Project 3.1 (WADC) structures on the Cherokee event to obtain loading and response data with electronic gauges, to include free field blast measurements at the location of the structures.

Project 1.6 - Directional Drag Force Measurements (NOL)

To measure directional drag forces on selected simple shapes as a function of time on Shot Lacrosse I, using electronic instrumentation.

Project 1.8 - Crater Measurements (ERDL)

To measure the apparent crater on Seminole, Lacrosse I, and Zuni, as well as any other land surface burst, using photo-mapping techniques and lead line soundings.

Project 1.9 - Water Wave Studies (SIO)

To measure water waves at short and long ranges from Zuni, Cherokee, Navajo, Tewa, and Apache. (Limited measurements in Bikini Lagoon on Flathead and Huron are considered desirable provided project funds are available and little or no movement of instruments or stations are required.)

Project 1.10 - Vegetation Studies (SC)

To measure static and dynamic pressure vs time at various ranges over a vegetated and cleared area from Shot Inca using electronic instrumentation.

5. Priority

a. Projects 1.3, 1.4, 1.1 in that order on Cherokee.
b. Projects 1.2, 1.3, 1.5 in that order on Lacrosse.
c. Project 1.10 on Inca.
d. Project 1.8 on Seminole, Lacrosse and Zuni in that order.
e. Projects 1.1 and 1.5 in that order on Yuma.
f. Project 1.5 on Cherokee.
g. Project 1.6 on Lacrosse.
h. Projects 1.3, 1.1, 1.5 in that order on Zuni.
i. Project 1.9 on Zuni and Cherokee in that order.
j. Project 1.9 on Navajo, Tewa, Apache, Flathead and Huron in that order.
k. Project 1.1 on Lacrosse and Inca in that order.
l. Project 1.3 on Inca.

PROGRAM SUMMARY
OPERATION REDWING

Program 2

Gamma Exposure vs Distance - Project 2.1
Gamma Dose Rate vs Time - Project 2.2
Neutron Flux Measurements - Project 2.5

1. Philosophy

Project 2.1: Prior test experience has yielded complete information for gamma dose vs distance for weapon yields below the megaton range. A need exists for additional data for high yield airburst and surface burst weapons since only four data points are in existence to date (from CASTLE).

Project 2.2: At Operation CASTLE the only initial gamma dose information which was capable of being interpreted was obtained by means of dose rate vs time measurements. It is believed advisable to make a very limited effort to measure initial gamma again by this means as a back-up for measurements made by dosimetry, Project 2.1, in order to avoid the possible complete loss of test data due to blackening of film badges by fall-out. It is considered very important to measure the residual gamma dose as a function of time in support of the fall-out analysis.

Project 2.5: Present knowledge of neutron radiation dose is considered unreliable for all low yield devices. Since neutron flux does not scale directly with yield it is necessary to investigate the energy spectrum characteristics in addition to total dose in order to estimate biological damage. Considerably more uncertainty exists in prediction of the neutron hazard than that from gamma radiation.

2. Objective

To determine the initial nuclear radiation effects with sufficient accuracy for military purposes.

3. Measurements

Project 2.1: Film badge and other dosimetry devices will be used to measure the initial gamma dose as a function of distance on all high yield tests.

Project 2.2: Limited measurements will be made of the initial gamma dose vs time for high yield tests, particularly the airburst. Extensive documentation is planned for residual gamma dose rate vs time on those tests of interest to the fall-out projects.

Program 2 (contd)

Project 2.5: Neutron flux as a function of distance and neutron energy will be measured from all low yield detonations, the megaton air burst, and a so-called "clean" weapon.

4. Priority

Considerable importance is believed to exist in connection with these projects. In the dose rate vs time measurements, the residual rate is considered to have primary importance over the initial rate.

PROGRAM SUMMARY
OPERATION REDWING

Program 2

Decontamination and Protection - Project 2.4
Ship Shielding Studies - Project 2.7
Ships Countermeasures Methods Studies - Project 2.8
Standard Recovery Procedures Evaluation - Shipboard - Project 2.9
Washdown Effectiveness Evaluations - Project 2.10

1. Philosophy

Certain gaps exist in the knowledge of techniques to combat the fall-out hazard. Decontamination methods need to be developed which will handle wet contaminants, which are very tenacious and would present a serious recovery problem in the case of a harbor burst. The reduction in dose rate to be expected in below-decks locations when the deck is contaminated is not known, but it can be evaluated if the shielding characteristics of various ship structures and geometries are measured.

On previous tests, various methods of reducing shipboard contamination have been tested, including removable protective coatings, paint stripping, mechanical scrubbing, protective covers and a spray or washdown system operated during fall-out. New developments in these methods must be evaluated to determine their effectiveness.

2. Objectives

a. Project 2.4: By means of test panels located on the YAGs, investigate the effectiveness of present methods of decontamination for water-borne radioactive particulate. Chemical laboratory procedures will be used to increase present knowledge of mechanism of penetration of particles into various surfaces.

b. Project 2.7: Determine by use of film badges and portable instruments only such shielding characteristics as can be used to extrapolate results to other ships of the fleet.

c. Project 2.8: Determine the effectiveness of new protective coatings for shipboard use to facilitate decontamination.

d. Project 2.9: Test a proposed recovery procedure for tactical decontamination of ships.

e. Project 2.10: Test the effectiveness of shipboard washdown systems.

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Projects 2.4 and 2.7 thru 2.10 (contd)

3. Instrumentation

a. Project 2.4: Panels of field and fixed installations outside material surfaces will be mounted on each of the ships used for fall-out collection, and on one land station where heavy contamination is expected.

b. Project 2.7: Film badges and portable instruments, including gamma vs time recorders, will be positioned on the YAGs used in collecting fall-out.

c. Project 2.8: Standard U. S. Navy and special USNRDL-developed radiac instruments will be used to monitor the decontamination procedures on the YAGs.

d. Project 2.9: Standard and proposed radiological instruments will be used in the test of tactical recovery procedures on the YAGs.

e. Project 2.10: No additional instrumentation required, since the information obtained from other projects will be sufficient to supply the data needed to verify the washdown effectiveness.

4. Operational Considerations and Priority

These projects plan to use the ships assigned to the fall-out study, since these ships will be so positioned as to be in the downwind residual contamination pattern. The basic mission of the fall-out study will have priority, and these projects are on a non-interference basis. They will participate on the same three tests as the fall-out study, Cherokee, Zuni and Navajo.

PROGRAM SUMMARY
OPERATION REDWING

Program 2

Rocket Sampling of Fall-out at Early Times and High Altitude - Project 2.61
Fall-out Contours by Oceanographic Analysis - Project 2.62
Characterization of Fall-out - Project 2.63
Early Aerial Survey - Project 2.64
Land Fall-out Studies - Project 2.65
Early Cloud Penetration - Project 2.66

1. Philosophy

This program represents a much larger effort than has been allotted to fall-out in previous test operations. The increased effort to establish the fall-out contours is based on the results of Operation CASTLE, in which the magnitude of the fall-out hazard was clearly indicated. The measurements in Operation REDWING are designed to establish reliable values of the areas affected, and to assist in the construction of a realistic model of the phenomena which will permit reliable extrapolation to different weapons, burst heights, and surface conditions.

2. Objective

The fall-out program is intended to document the hazard from air and surface bursts. This documentation will include the initial and final distribution of activity, the time history of accumulation, and the physical and chemical nature of the active material.

3. Measurements

a. Project 2.61: The initial distribution of activity will be measured, using data telemetered from rockets fired through several parts of the cloud and stem as soon as the cloud stabilizes and a few minutes later. The rockets will be timed so that they penetrate the various portions of the cloud and stem at the same time. The later set of measurements will give information on changes with time.

b. Project 2.62: The radiation intensity in the ocean downwind from the detonation will be mapped, and depth profiles will also be made to allow determination of the amount of contamination that has fallen on the surface. The YAGs are expected to furnish calibration check points for this survey.

c. Project 2.63: The time history of accumulation will be determined at a number of significant downwind locations with both moored and floating stations. These stations will also collect samples for physical and chemical studies.

Projects 2.61 thru 2.66 (contd)

d. Project 2.64: Aircraft will be equipped with radiation detection instruments, and will fly over the fall-out area to obtain a preliminary outline of the contour pattern.

e. Project 2.65: The activity deposited on land areas will be measured to establish the final distribution, the time history of accumulation, and the influence of the base surge. The land stations will also collect samples for physical and chemical analysis. The dose rate at 3 feet above the surface of the islands and lagoon of the shot atoll will be measured by a probe lowered from a hovering helicopter.

f. Project 2.66: The hazard to personnel in the cloud will be studied by measurements of the radiation intensity in the cloud at early times, using manned aircraft. Measurements will also be made of residual contamination on the aircraft, and samples will be obtained.

4. Operational Considerations

Participation is planned on five tests: Cherokee, Zuni, Flathead, Tewa, and Navajo. Although the Cherokee test is to be a true air burst and is not expected to produce a major fall-out pattern, it is necessary to document it in order to establish the actual pattern. The Zuni test of a cleaned up weapon must also be well documented to establish the expected reduction in residual contamination.

5. Priority

The data gathered by the many sub-projects must be correlated in order to obtain the complete analysis, since the results of each will be used in the interpretation of the data from the others. Hence no order of relative priority has been indicated but all effort must be made to reach all objectives in order to complete the project satisfactorily.

PROGRAM SUMMARY
OPERATION REDWING

Program 3

Effect of Load Duration on Structural Response - Project 3.1

1. Philosophy

When structural damage criteria were originally developed for atomic weapons, the simplest system was to define damage in terms of psi overpressure. Distances from ground zero for damage to various structures could then readily be obtained by $W^{1/3}$ scaling for the appropriate pressures. It was generally realized that damage was related to the duration of the blast loading but the variation of duration for the limited range of weapon yields then in existence was not significant. In 1953 when weapon yields became almost unlimited the study of duration effects was undertaken, most prominently by Professor N. M. Newmark, University of Illinois. By a simplified analysis it was shown that the then current damage criteria grossly underestimated the area of damage for drag targets when subjected to megaton weapon blast waves. This revision of criteria was based on a simplified mathematical model of a structure, viz. a one degree of freedom mass-spring system, and was not readily accepted by some involved in target analysis. In fact some statements were made that the duration effect must be completely demonstrated in full scale tests before the new criteria could be accepted. This then required full scale tests of similar structures exposed to both short duration and long duration bursts. The short duration exposure has already been accomplished in Project 3.7 of Operation TEAPOT. There are many uncertainties in the whole problem. The primary ones are (1) what loading does the structure receive, (2) what are the static and dynamic resistance-deflection curves of the structure, and (3) how well does a one degree of freedom system represent a structure. This project will go a long way in answering all three of the above questions for the particular structures tested. With further analysis, laboratory work, and correlation of shock tube and wind tunnel data, the answers to these questions for any structure will be improved greatly in reliability. The method of testing the structures is such that identical structures are exposed to blast loadings of different pressures and durations. Thus the resistance-deflection curves and, therefore, the form of dynamic response will not vary appreciably from structure to structure. The loading varies considerably, however, but since the loading area does not vary and the response is consistent, the drag coefficients should be well established. The test is such that the reliability of the one degree of freedom representation can also be well established since the structural characteristics are constant and, therefore, not susceptible to various adjustments to fit the predictions to the test results.

2. Objectives

a. To establish the reliability of a one degree of freedom mathematical model in representing the response of a single story industrial building.

Project 3.1 (contd)

b. To improve the means of estimating drag loading of structures (information is very meager regarding local drag shielding).

c. To compare computed and actual resistance-deflection curves of a structure.

d. To demonstrate partially the difference in duration effects for drag targets and semi-drag targets (a target on which the significant blast loading is a combination of drag loading and loading during the diffraction phase.)

e. Minor objectives are to:

(1) Obtain an idea of load transmitted by transite siding to structure frame.

(2) Ascertain mode of failure of structure components and connections.

3. Priority

Only project in program.

PROGRAM SUMMARY
OPERATION REDWING
Program 4

Flash Blindness - Project 4.1

1. Philosophy.

During BUSTER-JANGLE in 1951 the first studies on the glare effects of nuclear explosions were performed. These first studies were performed under daylight conditions. These studies were amplified and refined during operation UPSHOT-KNOTHOLE in 1953. It was during the latter series that investigations revealed that chorioretinal burns could be caused by the flash in rabbits at distances up to 42 miles. As a result of these investigations, recommendations were made to SAC and ARDC as to possible protective measures. It is felt that these recommendations require field testing. In addition many questions about the production of chorioretinal burns remain unanswered and are urgently needed.

2. Objective

a. To evaluate the visual handicap which may be expected in military personnel exposed either during daylight or night-time operations due to the flash of an atomic detonation.

b. To provide essential information about the behavior of lid reflexes under illuminations as high as those produced by atomic devices.

c. To test devices designed to protect human eyes against flash blindness and flash burn.

3. Operational Requirements

An aircraft will be required to transport 500 - 550 rabbits, 40 monkeys, electronic gear, animal exposure facilities, personnel, etc., directly from the School of Aviation Medicine, Randolph Air Force Base to the Pacific Proving Ground. Animal quarters will be required on Japtan Islands. Timed spectro-graphic and calorimetric measurements will be made in conjunction with Program 8. "Line of sight" exposure stations on various islands will be required. High speed photography will be needed to measure the blink reflex. The exposure sites must be in locations which will receive from 1-5 cals/cm^2. The exposure cages must be placed above the height of the expected water wave at the exposure site. The animals must be placed in exposure cages no more than 8 hours prior to shot time. The recovery of the animals should be as expeditious as possible (within 8 hours). Participation in the following shots is planned: Cherokee, Erie, Zuni, Mohawk, Flathead, Osage and Lacrosse.

4. Priority

Only project in this program.

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PROGRAM SUMMARY
OPERATION REDWING

Program 5

B-47E - Project 5.1
B-52 - Project 5.2
B-57 - Project 5.3
B-66 - Project 5.4
F-84F (2 aircraft) - Project 5.5
F-101A- Project 5.6
A3D-1 (Navy) - Project 5.8

1. Philosophy

The capability of manned military aircraft to deliver nuclear weapons is limited by the blast, thermal and nuclear radiation effects of the delivered weapon at the time it is detonated at the target. It has been shown by theoretical analysis and demonstrated by tests that for low yield weapons delivered by bombers the critical blast effects extend to greater ranges than thermal or nuclear radiation effects. Therefore, the low yield delivery capability of a given bombardment type aircraft is limited by blast effects. Theoretical methods have been developed for computation of the delivery capability limits. Calculated limits have been verified for older aircraft and low yield weapons by participation in past atomic test programs.

For high yield weapons, calculations indicate that thermal effects are more likely to limit delivery capability than are the blast effects. However, by relatively minor changes in design the aircraft's vulnerability to thermal effects may be substantially reduced. Examples of these changes are increasing skin thickness in critical areas, providing protective paints, and eliminating exposed highly vulnerable materials. With the increased resistance to thermal effects, the combination of stresses induced by thermal inputs and blast inputs are of more significance. Though delivery capability limits have also been computed for high yield weapons, uncertainties of the interaction of blast and thermal effects and the response of aircraft to these effects require that the computed limits be verified by full scale testing.

A B-47 and B-36 participated in high yield tests at Operations IVY and CASTLE. The delivery capability of the B-36 was adequately verified. Skin temperature rises in the B-47 were consistently lower than rises predicted for the measured inputs.

2. Objective

Seven Air Force and one Navy instrumented weapon delivery aircraft will be operated near detonations of Operation REDWING to investigate the responses of the aircraft structures to weapon thermal and blast effects.

Projects 5.1 thru 5.6 and 5.8 (contd)

The primary objective of the tests is to assure that the weapon delivery handbook for each aircraft type is reliable and that it correctly defines the maximum delivery capability of the aircraft. A secondary objective is the collection of basic input and response data for use in theoretical analysis of the delivery capability of other aircraft types. The objectives will be accomplished by positioning the test aircraft at points in space relative to test detonations corresponding to positions which could exist in actual tactical operations at detonation of a weapon delivered by the aircraft.

3. Measurements

Participating aircraft will be instrumented to measure the thermal and blast inputs and corresponding responses of the aircraft structure and engines. The instrumentation will have been planned, installed, and calibrated by participating agencies well in advance of Operation REDWING. In fact, four of the aircraft were partially instrumented during production in anticipation of this type of testing and for other flight loads testing programs. Typical instrumentation for a single aircraft will include the following:

a. Calorimeters for measurement of total thermal energy.

b. Radiometers for measurement of thermal intensity.

c. Pressure transducers for measurement of blast overpressure.

d. Thermocouples mounted on critical wing, stabilizer, and fuselage, skin and structural components for measurements of temperature rise.

e. Strain gages mounted on critical wing, stabilizer, and fuselage components for measurements of thermal stresses and combined thermal and gust loading stresses.

f. Sensing devices to indicate engine temperature and pressure variations resulting from thermal and blast effects.

g. Accelerometers at various locations within the aircraft to measure total and differential accelerations.

h. Recorders to receive and record data from all of the sensing devices above.

i. Cameras to record engine instrument fluctuations resulting from weapon effects.

In addition to the instrumentation listed above, the four bombardment type Air Force aircraft will incorporate additional instruments for collection of basic thermal data for Project 5.7.

4. Operational Considerations

Successful completion of these delivery capability tests requires precise positioning of the test aircraft at a predetermined position with respect to the detonation where near design limit stresses and skin temperature increases will be attained. On the other hand safety considerations do not allow positions where aircraft design limits will be exceeded or where nuclear radiation will endanger aircraft crews. Therefore, the time and distance limitations for positioning fall within narrow limits. Both the Air Force and the Navy are assembling radar and radio navigation systems for use in positioning and tracking the Operation REDWING aircraft. At Bikini, bombardment type aircraft will be positioned by integral airborne radar systems and Raydist radio systems will be used for positioning four aircraft and for tracking all aircraft to provide accurate recorded locations at detonation and shock arrival. At Eniwetok, integral radar will be used for positioning bombardment aircraft and MSQ-1A radar will be used to position and track other aircraft.

It is proposed that each aircraft be exposed at each high yield detonation. Low yield delivery capability will also be verified for most aircraft at selected Eniwetok tests.

Cloud cover will seriously interfere with thermal measurements of aircraft. In the event that some aircraft do not successfully participate in scheduled shots because of unfavorable weather or other operational difficulty, alternate participation at Tewa in July should be considered.

5. Priority of Tests

The delivery capability projects of Program 5 are of approximately equal priority with respect to each other at any one shot. Factors which should be considered if it is necessary to assign priorities within the program are the following:

a. The relative importance of the B-52 and B-47 in the total military aircraft inventory.

b. The additional basic thermal measurements being made on aircraft of Projects 5.1 thru 5.4 in support of Project 5.7.

c. Project 5.8 is the only Navy project in the program and should merit some consideration for this reason.

d. Project 5.6 plans measurements at aircraft velocities above the speed of sound, a velocity region which will be of increasing importance in studies for future development.

Projects 5.1 thru 5.6 and 5.8 (contd)

For the objectives of Program 5, the shots which will likely yield most useful data are listed in order of importance as follows:

(1) Cherokee
(2) Navajo
(3) Zuni
(4) Apache
(5) Huron
(6) Flathead, Mohawks
(7) Lacrosse, Erie, Seminole, Kickapoo

This listing is based on consideration of currently available data on air bursts and surface bursts, ratio of probable yield to positioning yield and probability of measuring similar data at future continental tests.

PROGRAM SUMMARY
OPERATION REDWING

Program 5

Weapons Effects on Missiles Structures and Materials - Project 5.9

1. Philosophy

There is an urgent need for the capability to destroy, or render ineffective, the nuclear warhead of an enemy intercontinental ballistic missile (ICBM). The use of nuclear warheads in guided missiles is under consideration for this capability. Of the many effects from such a defensive weapon, the most important is believed to be that of neutron heating of the active material of the ICBM. However, the effects of thermal radiation, blast, and acceleration are not well known at distances engulfed by the fireball, and should be measured.

There is also an important need for thermal heating information for use in the design of our own ICBM to withstand the heat generated on re-entering the earth's atmosphere. Static tests of thermal fireball heating should contribute useful information for this purpose at REDWING, and if the need is then felt to exist, dynamic tests can be considered at a subsequent operation.

2. Objective

The general objective will be to define the probable vulnerability of ballistic missile structures and materials to nuclear fireball and other associated phenomena. Specifically it is hoped to determine:

a. The comparable susceptibility of certain ballistic missile materials to fireball environment.

b. The characteristic gust accelerations, overpressures, and thermal energy produced by the fireball.

c. The response of basic structural configurations to nuclear explosions.

d. The response of hypersonic test vehicle nose cones in static exposures to nuclear detonations.

3. Measurements

Measurements of blast induced reactions will be obtained by self-contained accelerimeters. Passive temperature indicators will be incorporated into several test specimens to find the temperature attained within the specimens.

Project 5.9 (contd)

4. Operational Considerations

A 20 KT tower shot and a 1 MT surface shot is desired for this project. An area comprising the land included in a 60° sector, about 1,000 feet in radius from GZ will be required for the 20 KT shot while a 20° - 30° sector extending about 6,000 feet in radius from GZ will be required for the megaton shot. Shielded, remotely controlled equipment to open the spherical specimens will be needed. It may be necessary to decontaminate equipment and test specimens. Recovery of test specimens soon after the test will necessitate helicopter service. Light television towers will support the test specimens for the 20 KT shot and concrete pylons will support the test specimens for the megaton shot.

5. Priority of Tests

The results of this project are necessary for the design of defenses against ICBM. The same results will be used for design of ICBM warheads. Therefore, a high priority should be placed on this project in order that it reach its objectives.

PROGRAM SUMMARY
OPERATION REDWING

Programs 8 and 5

Albedo and Thermal Flux Measurements from Aircraft - Project 5.7
Basic Thermal Radiation Measurements - Project 8.1
Materials Exposed to Thermal Radiation - Project 8.2
Evaluation of Self-Recording Thermal Indicators - Project 8.3
Airborne High Resolution Spectral Analysis - Project 8.5

1. Philosophy

a. Operation REDWING will have scheduled as one of the events a high yield air burst. To date there have been no air bursts of high yield nuclear weapons and consequently considerable uncertainty exists in regard to the phenomenology of this type of burst. Information presently used for effects computations for large yield air burst weapons, such as thermal yield, time to the minimum and maximum, and color temperature are simply extrapolated from nominal and near-nominal sized air burst weapons. Although the IVY King shot was meant to be an air burst, it did not turn out to be one and the thermal measurements obtained were confusing and inconclusive relative to air burst weapons. Therefore, a primary mission at Operation REDWING will be to document, as fully as is possible, the phenomenology associated with a multi-megaton air burst weapon. Thermal measurements, however, will be made on several other shots. It is felt that the expense is minimal and the measurements obtained will supplement and verify existing data and scaling laws.

b. For large yield weapons, present calculations indicate that the delivery capability for aircraft is limited by thermal effects. The thermal radiation from a nuclear detonation incident on an aircraft can either come from the point of detonation or by way of reflections from the terrain or clouds. Further, in order to fully specify the radiant energy for effects computations, it is necessary to know the spectral distribution of the radiant energy. Many thermal measurements have been made at previous tests but the vast majority of them have been made from points on the ground. The few measurements that have been made in the air have shown beyond doubt that airborne targets receive thermal doses which are considerably different than ground targets at comparable distances from the point of detonation. The thermal dose differs in both intensity and spectral distribution; the two qualities that are absolutely necessary for computing effects on materials. Since the direct radiation to airborne targets does differ so, as compared to ground targets, it is believed that an airborne target "sees" a different fireball than do surface targets. In addition, it is felt that the role of reflections from the terrain might contribute more to the total thermal energy incident on airborne targets than was hitherto thought to be the case.

~~RESTRICTED DATA~~
~~ATOMIC ENERGY ACT~~ 1954

Programs 8 and 5 (contd)

c. One of the major consequences of an atomic detonation is the induction of fires in various types of fine fuels at considerable distances from the point of detonation. Present calculations show that for small or nominal sized weapons at given ranges, blast effects will predominate over thermal effects. For large weapons, however, it appears that the possibility of starting fires reaches considerably past the ranges of significant blast damage. It is therefore important to establish the critical energy of several fine kindling fuels for effects studies. Considerable data has been obtained in the laboratory in connection with the critical energies of various fuels for the weapon range 1 to 100 KT. The laboratory results have been verified in the field. At the present time there exists much laboratory information on the critical energies of these fine fuels for the longer pulses that are obtained with multi-megaton weapons. It is now necessary to verify the laboratory results of a few well understood materials at a field test.

d. There is at the present time no inexpensive self-recording device for measuring thermal flux which is not at the same time sensitive to strong shocks. At present field tests, each measurement of thermal flux necessitates a recorder channel (usually Heiland) which has to be protected from strong overpressures by a suitable shelter. While measurements obtained thus are satisfactory, the cost per channel is high and the recorders are always subject to mechanical damage while being handled. It therefore appears desirable to develop rugged, inexpensive self-recording instruments to measure thermal fluxes at future field tests.

2. Objectives

a. The primary objective of Project 8.1 will be to document the thermal phenomenology associated with a high yield air burst weapon. A secondary objective will be to collect data on thermal phenomenology for several of the other shots at Operation REDWING.

b. Projects 5.7 and 8.5 will have as their major objectives basic measurements of the magnitude, directional distribution, and frequency distribution of the thermal energy at pre-selected air positions around the point of detonation.

c. Project 8.2 will have as its objective the determination of critical ignition energies for several types of thin kindling fuels for large yield surface and air burst weapons.

d. The objective of Project 8.3 is to evaluate three types of self-recording thermal indicators. It is particularly desired to study the action of these indicators when subjected to long thermal pulses that are obtained from megaton yield weapons.

Programs 8 and 5 (contd)

3. Measurements

Basic Thermal Radiation Measurements from Ground Positions: The following types of measurements with associated instrumentation will be taken at Operation REDWING, with emphasis for the high yield air burst:

a. Total thermal energy - calorimeters.

b. Total thermal energy versus time - radiometers, bolometers.

c. Integrated broad band spectral distribution - suitably filtered calorimeters.

d. Broad band spectral distribution versus time - suitably filtered radiometers.

e. High speed, narrow band spectral distribution versus time - a spectrometer with a one hundred microsecond resolution time.

Since a method of correcting for atmospheric attenuation must be worked out to extrapolate measurements back to the source, some atmospheric transmission measurements will be made. The equipment to be used, however, has not yet been definitely decided upon.

Thermal Flux, Albedo, and Spectral Measurements from Aircraft: Four Air Force aircraft will be instrumented with calorimeters, radiometers, and high speed cameras. These instruments will be used to measure the following:

a. Fireball size, shape, and rate of rise.

b. Spectral distribution of thermal energy.

c. Reflected radiation from surface and clouds.

d. Degree of nonisotropy of thermal radiation.

e. Black body characteristics of fireball.

f. Shadowing of reflecting surface by the fireball.

g. Attenuation of direct radiation as a function of the field of view and the wavelength.

The Navy aircraft will be instrumented with a high speed narrow band width spectrometer to find high resolution spectral characteristics of nuclear fireballs as a function of time. The spectrometer is the same as the one

Programs 8 and 5 (contd)

NRDL will be taking measurements with at a ground station.

Thermal Effects of High Yield Nuclear Weapons on Fine Fuels: Beds of fuel will be exposed within the range of 8 to 25 calories per square centimeter. Exposures will be made for both large yield air burst and surface burst weapons. The fuel beds will be located in close proximity to NRDL stations and thus measurements of total exposure, intensity versus time, and spectral distribution can be readily supplied.

Evaluation of Inexpensive Self-Recording Thermal Indicators: Two each of three types of instruments will be placed at each of about five stations to note the reactions of these instruments to large weapon thermal pulses.

4. Operation Requirements

a. Each project will have its own operational requirement; therefore, the projects are listed by number and the requirements of each are set forth.

b. Project 8.1: About five shelters will be needed to house the instrumentation. Timing signals of -30 minutes, -5 minutes, -30 seconds, -5 seconds, and -1 second will be needed. Several towers will be needed for the mounting of instruments as well as a machine shop trailer and an electronics trailer.

c. Project 5.7: It would be desirable from the data reduction point of view to position the four Air Force aircraft in pairs, each pair separated from each other by an azimuth angle of about 90 degrees and each aircraft of the pair flying nearly the same flight path but at a different slant range.

d. Project 8.5: The Navy aircraft will, in general, be located above the NRDL ground station for those events in which NRDL participates. When NRDL does not participate, the Navy aircraft will be as much over the point of detonation as is consistent with safety requirements.

e. Project 8.3: It is desired to have about five stations located up-wind to preclude fall-out on the instrumented areas. The nearest station should be no closer than the distance at which the overpressure is 25 psi, and the stations should be distributed within the thermal range 30 to 1 cal/cm^2. Steel poles approximately 5 feet high will be used to mount the thermal instruments.

5. Priority of Tests

The projects within the thermal program are here listed in order of estimated importance for the overall mission of obtaining thermal data at REDWING:

Programs 8 and 5 (contd)

a. Project 8.1: It is felt essential to document the phenomenology of a high yield air burst weapon (CHEROKEE) for effects predictions. This project must accomplish its mission in order that this data be obtained.

b. Project 5.7: There is little known at the present time about the thermal exposure an airborne target will receive from a nuclear weapon. This project will do much to clarify the problem.

c. Project 8.2: For reliable effects predictions at long ranges from a high yield nuclear weapon this project must accomplish its objectives.

d. Project 8.5: This project supplements Project 5.7 by taking more detailed spectral measurements of the thermal radiation. While an important project, it cannot be placed at the same level of importance as Project 5.7.

e. Project 8.3: This project is the least important one in the thermal program since the lack of these instruments will not excessively hamper any future program envisioned.